

Real-time Beryllium Analysis Programs at LANL

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Real-time Beryllium Analysis

Air particulate analysis

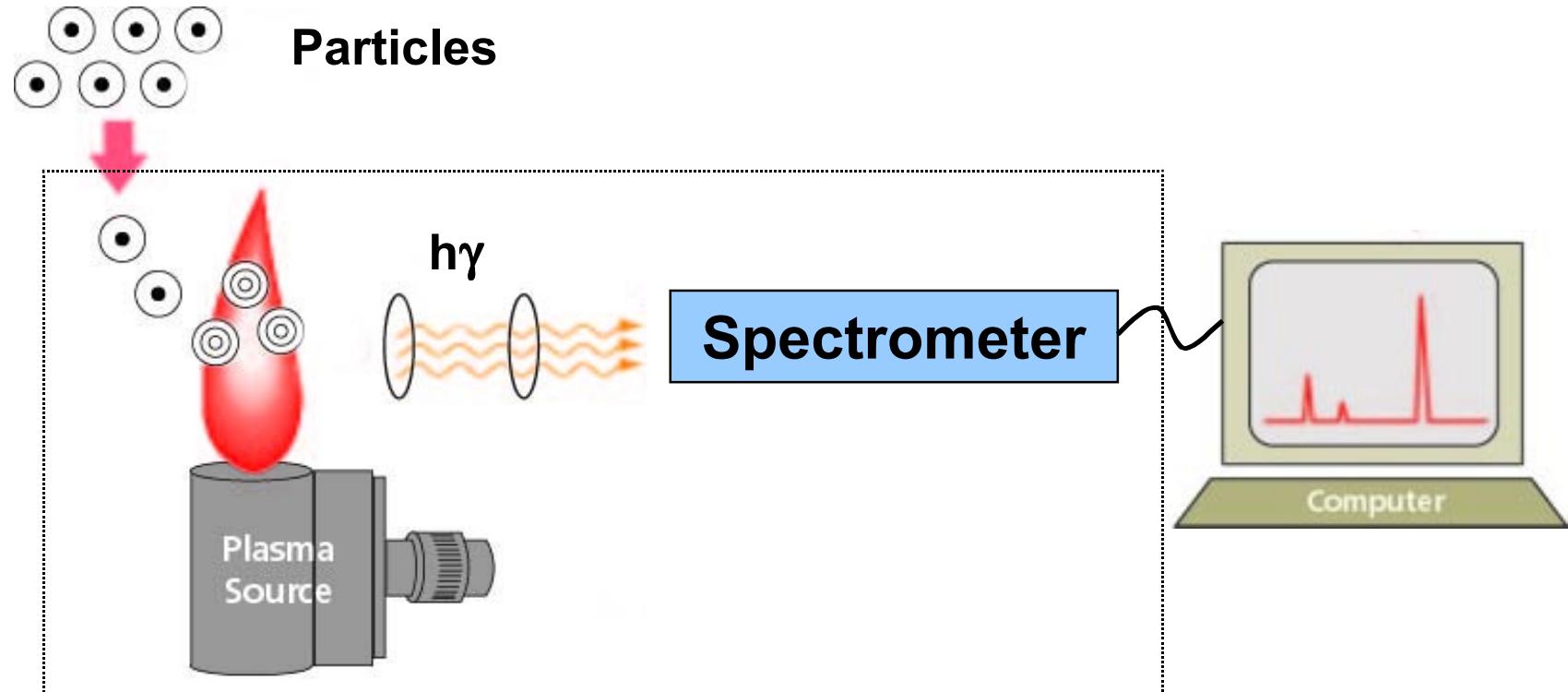
- Microwave Induced Plasma Spectrometer (MIPS)

Surface contamination analysis

- Laser Ablation/Ionization Time-of-Flight Mass Spectrometer (LAI-TOFMS)

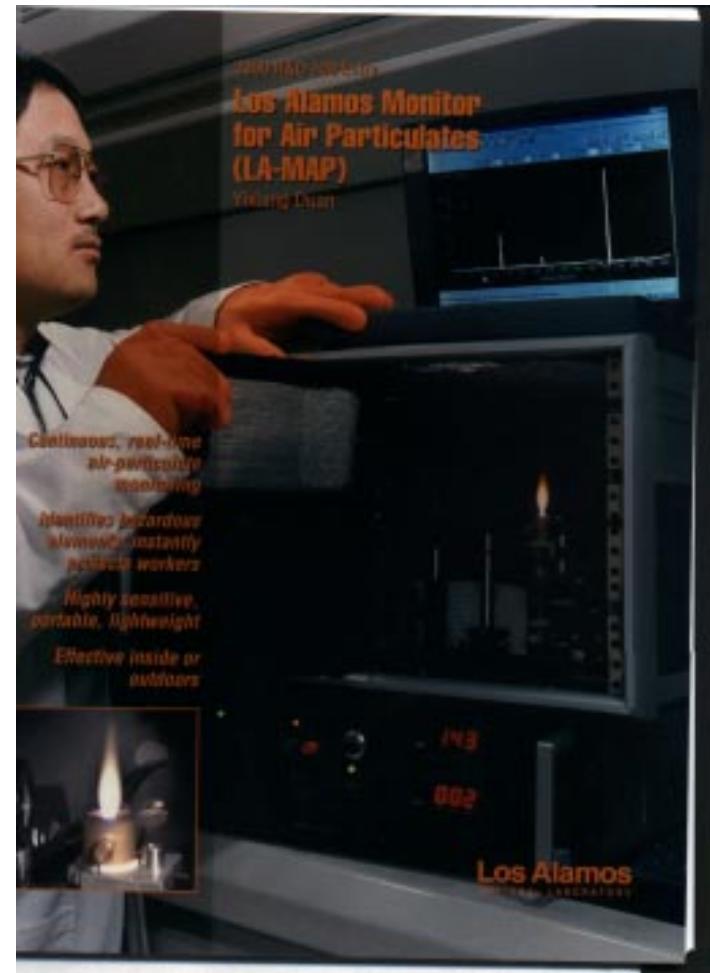


Microwave Induced Plasma Spectrometer (MIPS) Basic Principles of Operation



Advantages of the MIPS Monitor

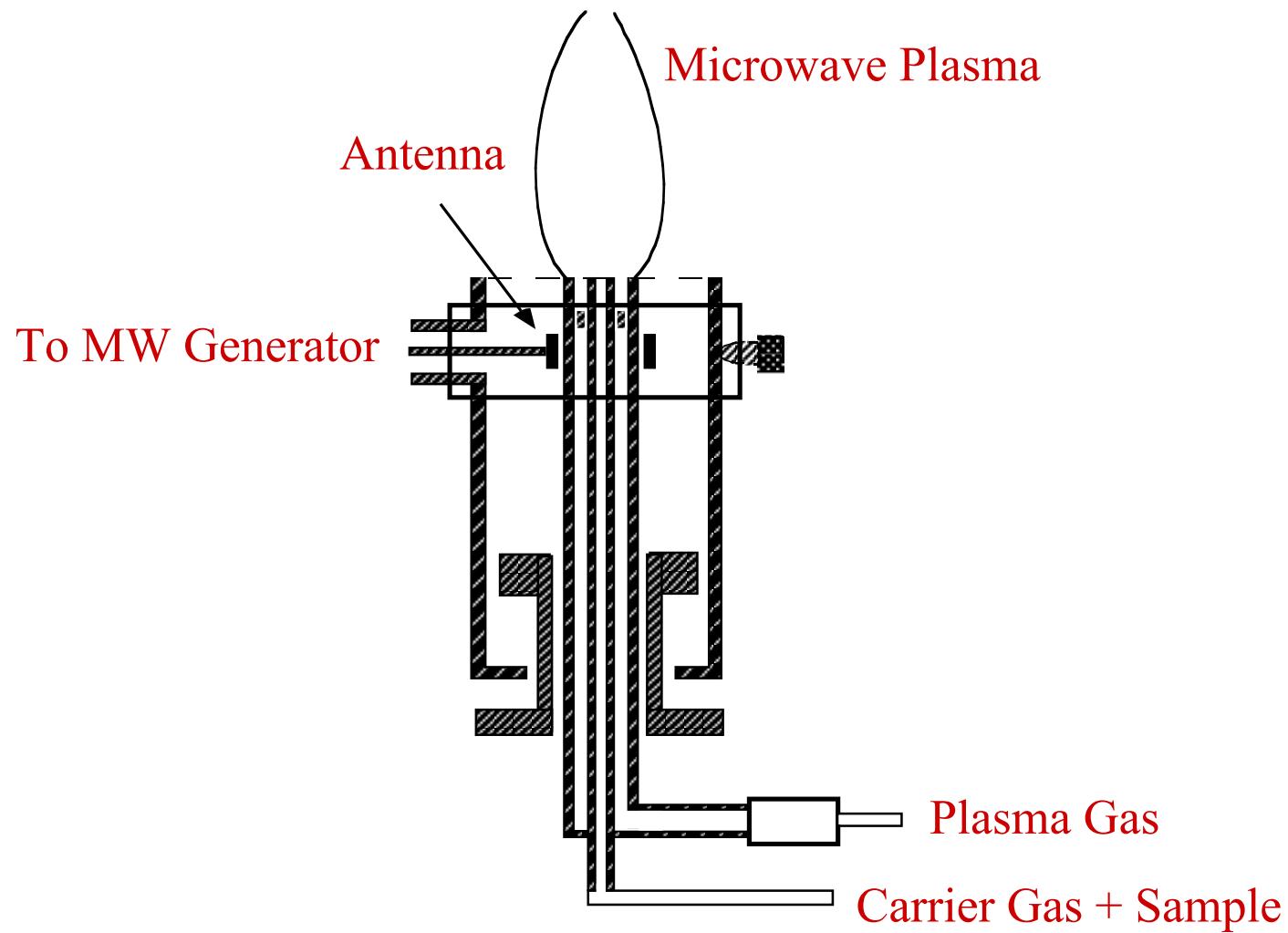
- Direct air sampling
- Real-time continuous monitoring
- High sensitivity
- Multiple element detection
- Few interferents
- Compact
- Low cost
- Easy to operate



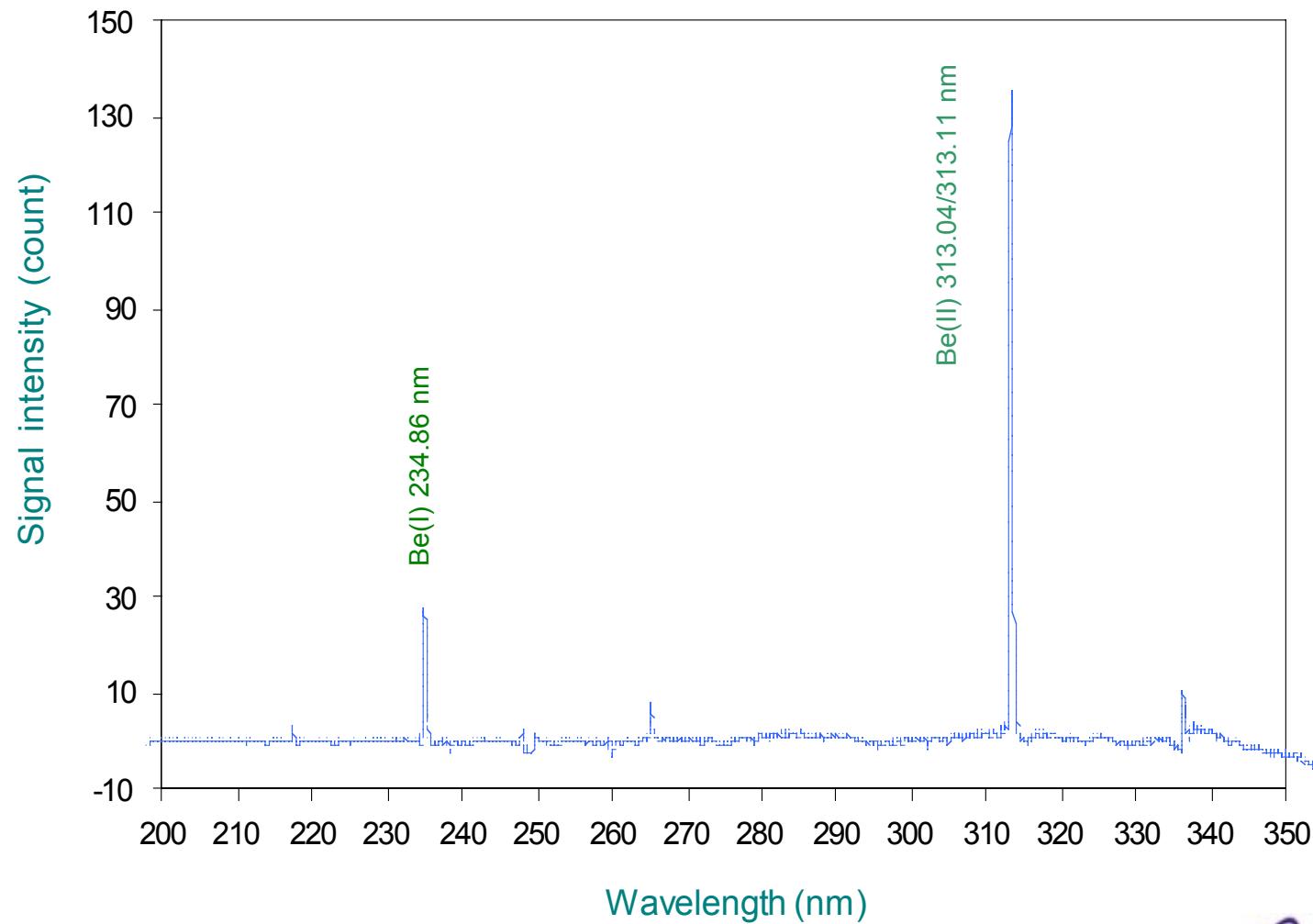
Plasma Features with and without Air Introduction



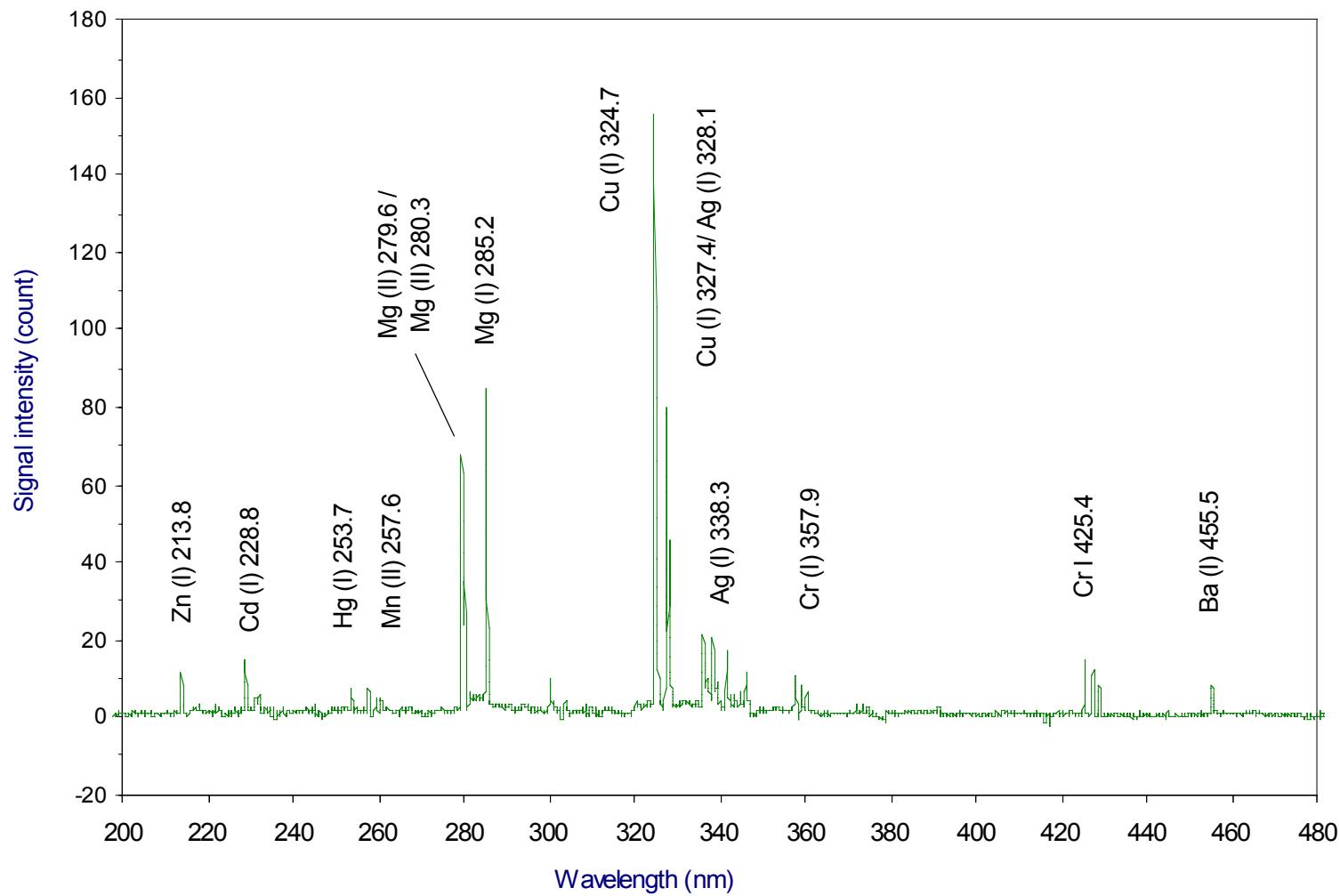
Detail of MIPS Torch



Beryllium Spectrum (10 ppb standard)



Multi-Element Spectrum

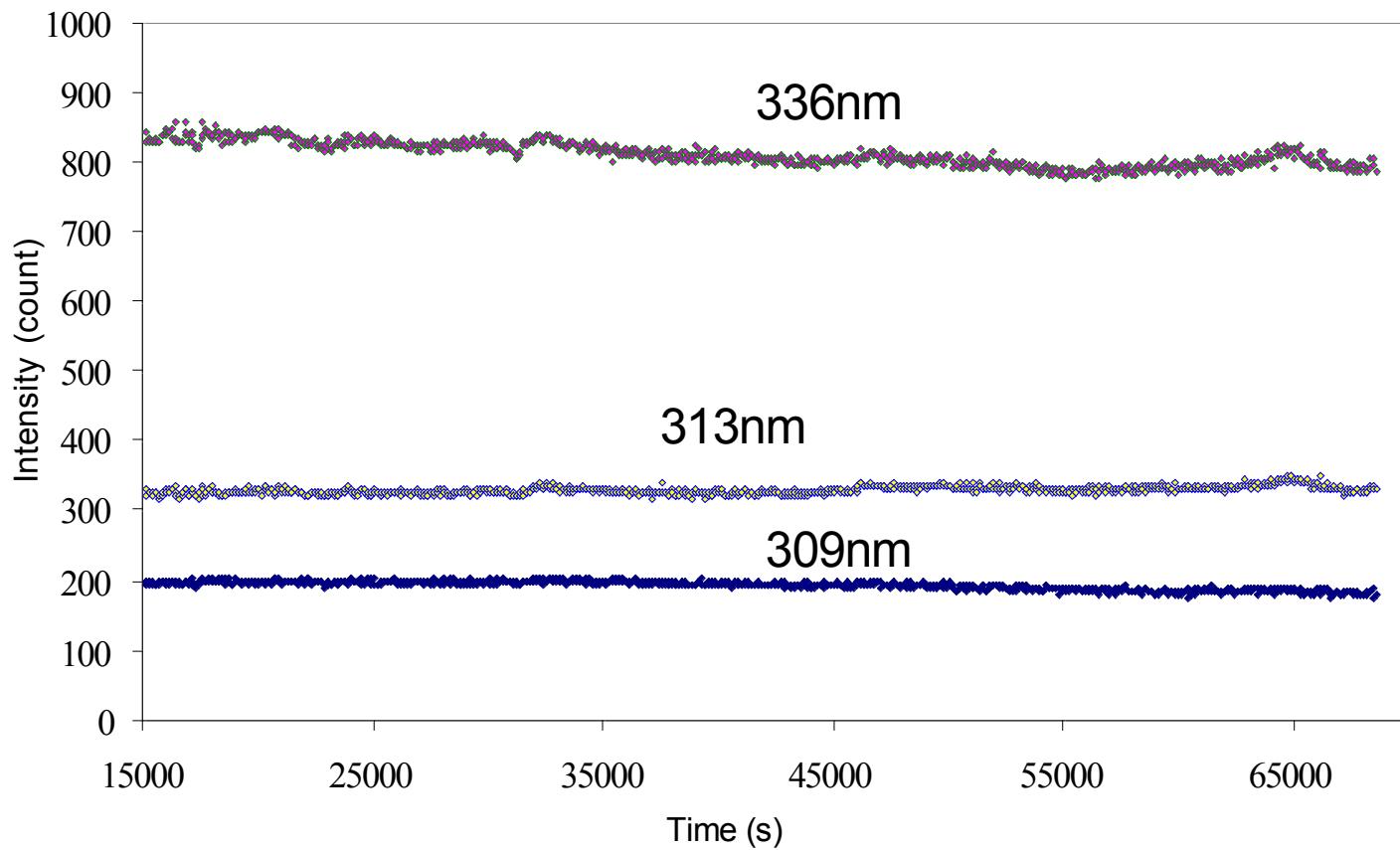


MIPS Detection Limits

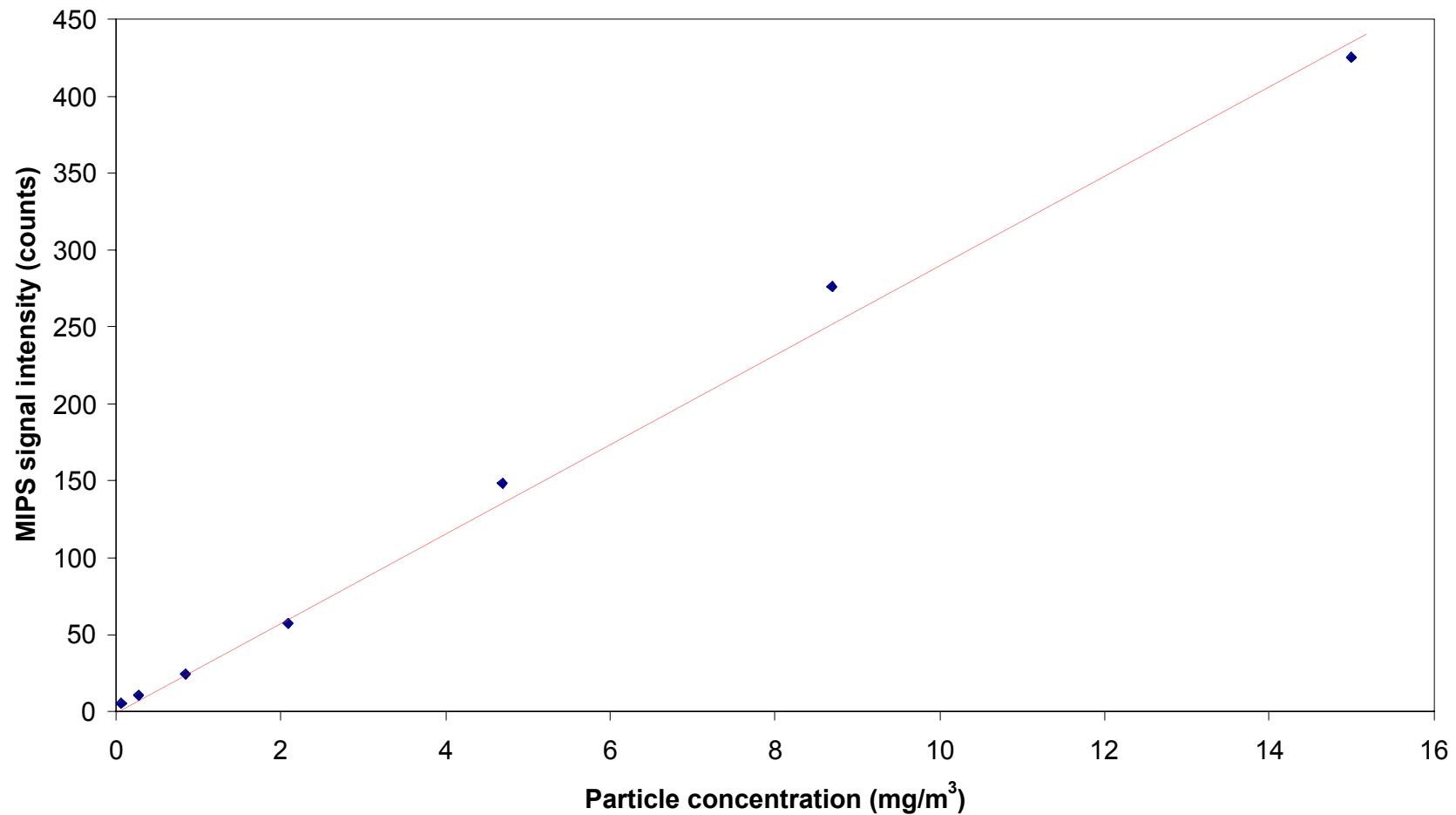
Element	Wavelength (nm)	Detection Limits ($\mu\text{g}/\text{m}^3$)
Ag (I)	328.1	0.47
Ba (I)	455.5	0.37
Be (II)	313.1	0.21
(I)	234.9	0.12
Cd (I)	228.8	1.3
Cr (I)	425.4	0.31
Cu (I)	324.7	0.088
Hg (I)	253.7	4.3
Mg (I)	285.2	0.14
Mn (II)	257.6	2.3
(I)	279.5/279.8	1.3
Zn (I)	213.8	2.2



MIPS Stability Tests



MIPS Particle Size Studies



Future MIPS Technical Work

- Determine effect of beryllium particle size
- Improve instrument
 - Redesign of air sampling system
 - Ruggedize hardware
 - Conduct field testing
- Work more closely with potential users
- Transfer technology to outside vendor

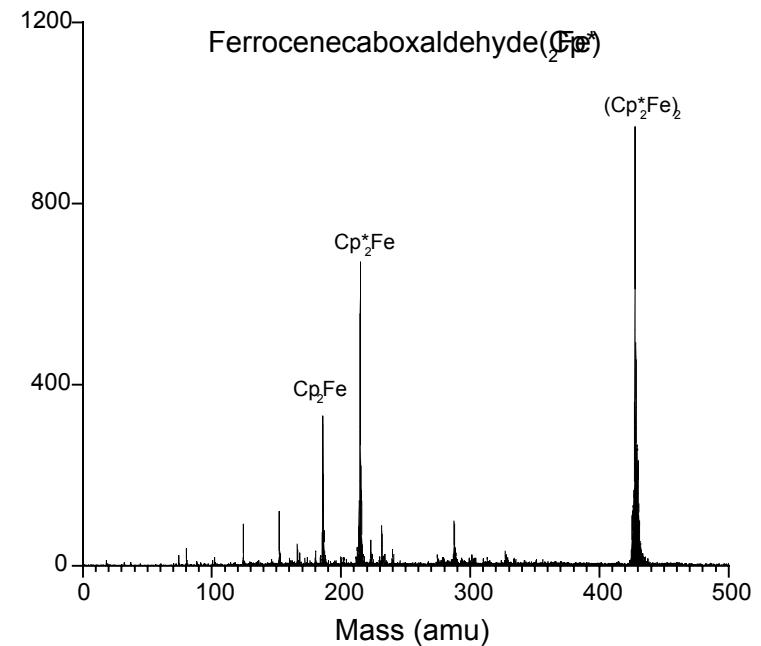
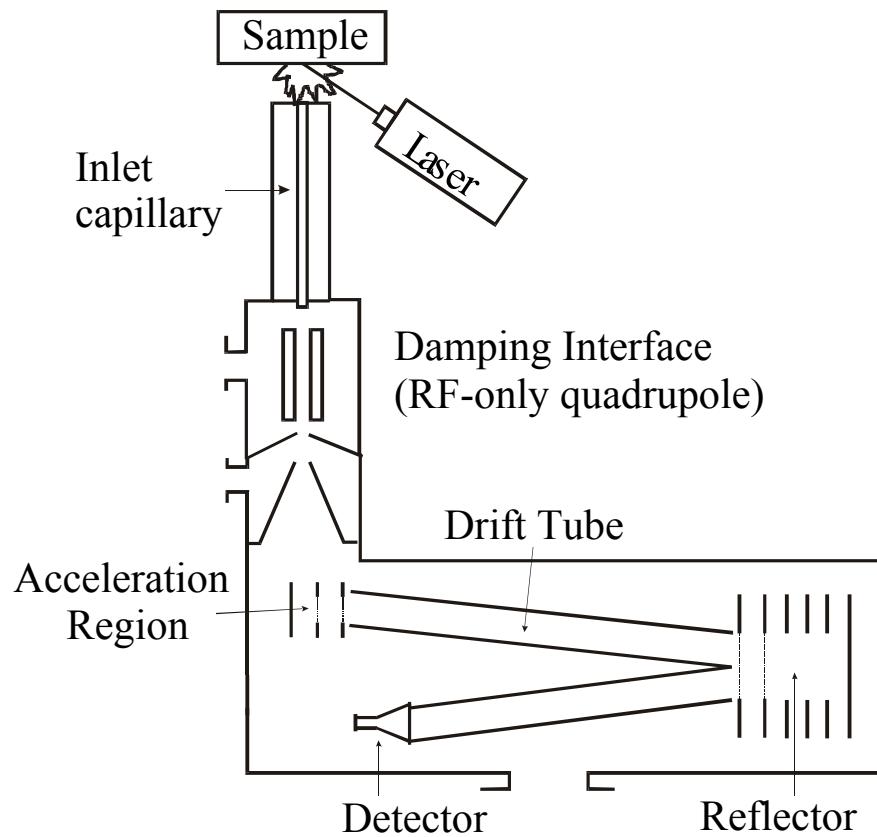


Requirements for Surface Contamination Analyzer

- Rapid portable analyzer
 - Simple
 - Sensitive
 - Automated
 - Minimal training required (“User Friendly”)
- Modular Design
 - Parts easily replaced
 - Minimal custom parts



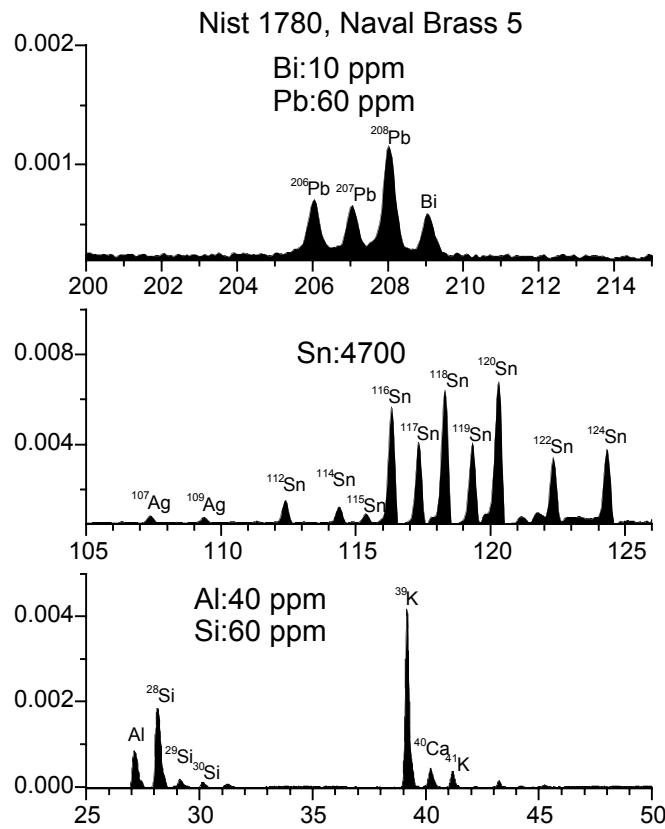
Laser Ablation and Ionization Time-of-Flight Mass Spectrometer (LA-TOFMS) for Solid Sample Analysis (in air)



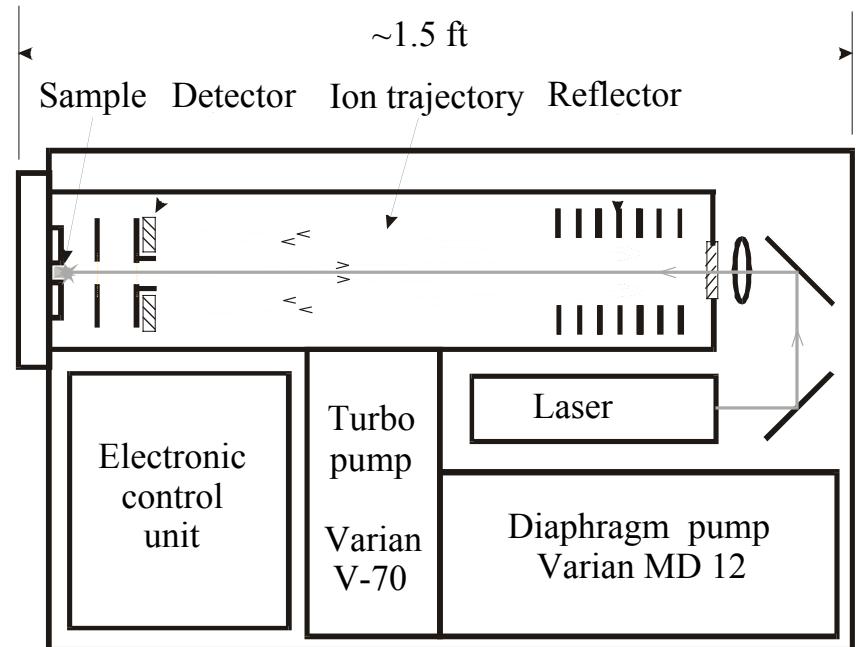
Mass spectrum of ferrocenecaboxaldehyde using atmospheric sampling laser ablation/ionization time-of-flight mass spectrometry.



LA-TOFMS for Solid Sample Analysis (in vacuum)



Preliminary mass spectrum of NIST 1780 Brass sample using in-house built laser ablation linear time-of-flight mass spectrometer.



Proposed portable miniature laser ablation time-of-flight mass spectrometer.

Advantages of LA-TOFMS

- Detection limits of ~100 ppb for most elements
- Multielement analysis capability
- Rapid analysis (seconds)
- Requires almost no sample preparation
- Essentially non-destructive
 - Total sample ablated during the analysis only $\sim 10^{-10}$ g
- Molecular species can be characterized by simply lowering the laser power.



LA-TOFMS versus LIBS Technology

- LA-TOFMS
 - Explicit spectra
 - Low background
 - Quantitation more straightforward
 - Easy isotopic analysis
- LIBS
 - Complex spectra
 - High background
 - Quantitation is very difficult
 - Isotopic analysis not feasible

LA-TOFMS Development Plan

- Develop *at-line* analyzer first
 - Validate on swipe samples
 - Direct comparison with lab results
 - Simplify for operation at DARHT
- Follow with portable *in-situ* analyzer
 - Ruggedize hardware
 - Conduct field testing



Summary

- MIPS provides required sensitivity for particulate analysis
 - Enhanced real-time worker safety assurance
 - Continuous operation
- LA-TOFMS facilitates surface analysis
 - More rapid turn-around at test facilities
 - At-line and in-situ analysis possible



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